

P 071826Z DEC 05
FM DIRJOAP TSC PENSACOLA FL
TO NAVOAPROGMGR PENSACOLA FL
CDR LOGSA
OC ALC
AIG 165
AIG 350
AIMD BAHRAIN
AIMD WHIDBEY ISLAND WA
CG 3RD MAW
CG 2ND MAW
CG 4TH MAW
CG 1ST MAW
CNATRA CORPUS CHRISTI TX
COGARD ENGLOGCEN BALTIMORE MD
COMFAIRMED NAPLES IT
COMFAIRWESTPAC ATSUGI JA
COMMARFORPAC
COMNAVVAIRSYSCOM PATUXENT RIVER MD
COMNAVVAIRES NEW ORLEANS LA
COMNAVVAIRFOR SAN DIEGO CA
COMNAVVSURFLANT NORFOLK VA
COMNAVVSURFPAC SAN DIEGO CA
COMVAQWINGPAC WHIDBEY ISLAND WA
ELU 1
ELU 2
HMX 1 QUANTICO VA
HQ USAF WASHINGTON DC
MALS 12
MALS 13
MALS 14
MCAS IWAKUNI JA
MCAS YUMA AZ
MIDLANTREGCALCEN NORFOLK VA
NAF ATSUGI JA
NAS SIGONELLA IT
NAS OCEANA VA
NAS WHIDBEY ISLAND WA
NAS FALLON NV
NAS KEY WEST FL
NAVAIRDEPOT CHERRY PT NC
NAVAIRDEPOT JACKSONVILLE FL
NAVSHIPYD AND IMF PEARL HARBOR HI
NAVTESTWINGLANT PATUXENT RIVER MD
SIMA MAYPORT FL
SIMA SAN DIEGO CA

USS ABRAHAM LINCOLN
 USS BATAAN
 USS BELLEAU WOOD
 USS BONHOMME RICHARD
 USS BOXER
 USS CARL VINSON
 USS DWIGHT D EISENHOWER
 USS ENTERPRISE
 USS ESSEX
 USS GEORGE WASHINGTON
 USS HARRY S TRUMAN
 USS IWO JIMA
 USS JOHN C STENNIS
 USS JOHN F KENNEDY
 USS KEARSARGE
 USS KITTY HAWK
 USS NASSAU
 USS NIMITZ
 USS PELELIU
 USS RONALD REAGAN
 USS SAIPAN
 USS TARAWA
 USS THEODORE ROOSEVELT
 USS WASP
 VAQ 129
 CC CNO WASHINGTON DC
 NAVAVNMAINTOFF CKA ORANGE PARK FL
 SUBJ/INTERIM RAPID ACTION CHANGE (IRAC) 4 TO NA 17-15-50.2, T.O. 33-1-37-2, TM 38-301-2 DATED 01 JUL 05//
 REF/A/COORDINATING GROUP MEETING TASKINGS DATED 16 NOV 05//
 NARR/-//
 POC/RESPONSIBLE CODE/MICHAEL CASSADY/JOAP MANUALS COORDINATOR/LOC: PENSACOLA NAS FL//00//
 /EMAIL: MCASSADY@JOAPTSC.NAVY.MIL / DSN: 922-5627 / TEL: 850-452-5627//
 RMKS/

1. This interim rapid action change is an official change to all holders of NA 17-15-50.2, T.O. 33-1-37-2, TM 38-301-2. U.S. Army and U.S. Air Force Oil Analysis Program Management addressees are responsible for promulgation of this change to applicable service activities.
2. PURPOSES OF CHANGES: provide guidance for oil contamination, modify or clarify requirements for laboratory data entry, clarify certain references.
3. DETAILED INFORMATION:

- A. Pen and ink changes to the technical content of a manual are not authorized. The following technical content change information applies to the following referenced pages and paragraphs of the subject manual until a formal change is released.
- B. JOAP Manual Volume II, Page 3-2, Section III (Spectrometric Laboratory Operating Procedures), Part 3-4 (Spectrometer Preparation and Operation), Subpart b (Atomic Emission Laboratories), Subsubpart (3) (Sample Excitation Stand Cleaning).

Delete last sentence. Replace with the following:

All personnel must adhere to the cleaning procedures and schedules given in the applicable instrument owner's manual. Refer to pages 2-9 and 2-10 of this volume for the applicable manual numbers.

- C. JOAP Manual Volume II, Pages 6-5 through 6-6, Section VI (US Navy Dielectric Coolant Testing), Part 6-2 (Coolant Testing Procedures), Subpart e (Test Data Reporting).

Page 6-5, Subsubpart (1). Replace last sentence to read as follows: To facilitate test data reporting, the use of specially prepared coolant analysis record (CAR) forms (Figure 6-2) is required.

Page 6-6, Subsubpart (2). Replace entire text with the following:

Two copies of the CAR form shall be prepared. One copy shall be provided to the customer; the second copy shall be retained by the laboratory in designated files or binders. In addition, each laboratory shall maintain a written index that contains the following: (i) list of samples received, (ii) dates received and analyzed, and (iii) the file/binder location of the associated results. When files or binders are maintained by calendar year, the index may be incorporated directly into the front of the file or binder; otherwise, a separate log book shall be used for the index. Test results shall be entered in the service's computerized database when this capability exists within the database. Entry of results is not required when unsupported by the computerized database. When the laboratory has the capability of entering data into the central service database and does in fact enter the data, the program manager may waive the requirement for a laboratory to maintain (i) the independent file or binder, (ii) index log book of results, or both.

- D. JOAP Manual Volume II Section IX, Pages 9-1 through 9-2 (Contamination of Turbojet Engines with Automotive Oil) revised; new title: Fluid contamination. Replace entire section.

Section IX. Fluid contamination

9.1. Introduction

This section discusses the contamination of lubricating and hydraulic fluids, how it occurs, how it is identified, what its impacts are, and what to do when contamination is suspected.

9.2. Types of contamination

Essentially, anything that is not supposed to be in the oil sump is a contaminant, regardless of its source. Contaminants may enter the system as a result of environmental exposure, normal operation, normal or abnormal wear, or human error (wrong fluid type).

9.2.1. **Environmental.** Environmental contamination occurs when materials normally present in the environment enter the oil. Environmental contamination can occur when fluid is transferred or when any reservoir (cart, pre-oiler, can, drum) is open to the environment. Environmental contaminants include (1) finely divided, airborne and windborne soil, dust, sand, or clay, (2) large particles of debris from contaminated surfaces, such as corroded cans, and (3) water from rain, snow, or other sources. Environmental contamination is largely a function of the environmental conditions under which fluids are stored and transferred and the care taken by personnel to ensure cleanliness and to protect transfer. Environmental contamination occurs when (1) bottles, cans, pre-oilers, or oil carts are left open or in unprotected conditions for extended periods, (2) closures malfunction or seals/gaskets have degraded, (3) drum or can surfaces are allowed to corrode and debris enters the oil as the container is opened, (4) dirty can openers, church keys, pour spouts, funnels, or nozzles are used, or (5) contaminants enter through the component air intake (or other exposure) as a result of normal operation. Improvements in personnel training and material handling equipment have reduced much of the environmental contamination.

9.2.3. **Wrong fluid type.** This results from human error (such as putting the wrong fluid in a pre-oiler) or sloppy handling (such as reusing a pre-oiler for a different type of fluid without proper cleaning). Contamination with the wrong fluid type most commonly occurs when an oil cart or pre-oiler (for example, PON-6) is filled with the wrong material at the maintenance site. However, it is also possible for mix-ups to happen in the supply system. Any time fluid is transferred between containers or to a vehicle's oil sump, there is an opportunity for contamination.

There are three general types of fluids used in aircraft: hydraulic fluids (MIL-PRF-83282 and MIL-PRF-5606), mineral lubricants [SAE J1899

(formerly MIL-L-22851D) and SAE J1966 (formerly MIL-L-6802E)], and synthetic lubricants (MIL-PRF-7808 and MIL-PRF-23699). However, there are many types of vehicles and components (engines, transmissions, gearboxes) enrolled in the JOAP. There are also many types of fluids used in servicing mechanical equipment (antifreezes or coolants, fuels, additives, lubricants, and hydraulic fluids). Any of these types of fluid may be inadvertently added to the oil sump or to an intermediate container (i.e., between the manufacturer's container and the sump).

9.2.4. **Wear debris.** Friction from moving parts and abrasion from environmental debris causes small fragments of metal to slough off into the oil. Excessive wear debris indicates poor engine health. For aeronautical equipment, nearly the entire oil analysis program is directed towards wear debris and engine health.

9.2.5. **Operational byproducts.** Chemical reactions that take place during combustion yield products that reduce oil quality and effectiveness. Soot is formed from the incomplete combustion of hydrocarbon fuels. Water formed by combustion and fuel vaporized during combustion may enter the oil. Sulfur and phosphorus compounds may occur as impurities in diesel fuel and will burn to produce acids that attack metallic parts. Heat and mechanical stress break down the long hydrocarbon chains of the compounds that make up the oil itself.

9.3. Identifying and measuring contamination

Much of the JOAP Manual is dedicated to detecting and quantitating wear debris contamination and/or operational byproduct contamination.

9.3.1. **Water.** Although water is an environmental contaminant, it is also an operational byproduct that forms as a result of combustion of hydrocarbon fuels; therefore, it is already addressed when it represents a significant threat to a component or to oil performance. Water is measured via the crackle test, Karl Fischer titrimetry, and infrared spectrometry. These topics are covered in Volume II Section V of the JOAP Manual and are a part of routine analysis for many samples.

9.3.2. **Particulate debris.** This includes environmental particulate debris and soot. Dust, sand, grit, clay, and soil can be encountered as environmental particulate debris. Silicon is present in sand (silicon dioxide). When silicon is found with aluminum, that suggests the presence of aluminosilicates found in soils and clays. High levels of iron, inconsistent with engine composition, may be from rust on a can, can opener, pour spout, or church key. Many aircraft engine oils contain low concentrations of silicon in the form of silicone pour point depressants that allow the oil to be dispensed easily in cold weather. Therefore, it is

normal to see silicon concentrations around 3-4 ppm and occasionally as high as 5-6 ppm. Silicon, aluminum, and iron are all quantitated via rotrode atomic emission spectroscopy, which is covered heavily in Volume II Section III, and to which the wear limit tables in Volumes III and IV are dedicated. In addition, particle counting is used for hydraulic fluids and covered in Volume II Section V.

9.3.3. **Wrong fluid type.** Wrong fluid type is normally found by identifying additives that would be absent in the correct fluid.

9.3.3.1. **Zinc.** High levels of zinc are consistent with MIL-PRF-2104 or other automotive lubricants. As of 2005, zinc dialkyldithiophosphate (ZDDP) compounds are still added as antiwear agents to engine oils. These compounds form protective zinc phosphate glasses on engine parts. ZDDP compounds are not used in turbojet oils.

9.3.3.2. **Molybdenum.** Although not routinely found in MIL-PRF-2104, many commercial automotive (e.g., 5W30, 10W40) and truck (e.g., 15W40, 20W50) oil formulations incorporate suspensions of molybdenum disulfide. Molybdenum disulfide is a solid lubricant, and it is found in both engine oils and anti-seizing compounds. Unfortunately, molybdenum is also used in many aircraft engine bearings (such as 4.0-4.5% in M50 steel). The presence of molybdenum alone is not diagnostic for wrong fluid type. When detected in the oil of a component that does not contain molybdenum, this finding does point to contamination with automotive/truck engine oil.

9.3.3.3. **Boron.** Historically, the presence of boron has suggested the presence of coolant in the oil since borates are used as buffers to control pH in cooling systems. Nevertheless, boron additives, such as boron nitride, are found as solid lubricants, especially in heavy weight (e.g., 20W50) commercial oils. As of 2005, boron compounds were not used in any qualified product under MIL-PRF-2104 in the Defense supply system, and the presence of boron should initially suggest contamination with antifreeze coolant.

9.3.3.4. **Magnesium.** Historically, the presence of magnesium has suggested the presence of coolant in the oil since magnesium compounds are used as detergents in cooling systems. However, it has become increasingly common for the same detergents to be used in automotive/truck engine oils. When detected in the oil of a component that does not contain

magnesium, this finding points to contamination with either automotive/truck engine oil or antifreeze coolant.

9.3.3.5. **Glycol.** Most antifreeze coolant formulas are based on ethylene glycol, but environmentally friendly formulations contain propylene glycol. The alcohol functional groups are observed by infrared spectroscopy. Contamination with antifreeze coolant occurs mostly in ground equipment and rarely in aircraft. Glycol contamination usually occurs simultaneously with water contamination.

9.3.3.6. **Analytical techniques.** Zinc, molybdenum, and boron are determined via rotrode atomic emission spectrometry. Glycol and some other additives can be determined by infrared spectrometry. Some services and some laboratories may not have all techniques available.

9.3.4. **Operational byproducts.** In addition to water, various acidic species may be formed by the partial combustion of hydrocarbon fuels or impurities in them; these are measured collectively as the total acid number. Though not a byproduct, vaporized fuel may enter the oil during operation, and so it is included here. Fuel contamination can be determined by decrease in the flash point or fuel sniffer (Volume II Section V) as well as a decrease in viscosity when severe. Decreases in viscosity are also associated with the degradation of the oil itself resulting from exposure to heat and mechanical shearing action.

9.3.5. **Wear debris.** Like environmental particulate debris, wear debris is determined primarily by rotrode atomic emission spectrometry. Most wear debris is too large to remain suspended in the oil so that it cannot be estimated by the oil's opaqueness to infrared light (unlike soot). Volume II Section III is devoted to rotrode atomic emission spectrometry.

9.4. Consequences of contamination

9.4.1. **Water.** Small amounts of water are dispersed by the surfactants in the oil; however, large amounts of water lead to the formation of sludge, which clogs the filter and increases the viscosity. As sludge forms, the oil becomes less effective at lubricating surfaces and less effective at conducting heat energy. This makes the engine work harder and wear out faster. Water also speeds corrosion.

9.4.2. **Environmental particulate debris and soot.** Depending on the particle size, these contaminants either interfere with the proper function of the dispersants and surfactants in the oil (leading to sludge formation) or

they abrade the moving parts of the engine. In most aircraft, large debris is removed by the oil filter so that the presence of individually visible particles (i.e., turnings, chunks, flakes, needles) suggests improper filter function. Even in ground equipment, individually visible particles suggest substantial engine wear and/or poor air/oil filtration.

- 9.4.3. **Wrong fluid type.** For aircraft, wrong fluid type can be an extremely serious problem. Aircraft consume oil at a rate such that any non-combustible or involatile compounds are rapidly concentrated and can clog filters or deprive the system of needed lubrication and heat transference. Furthermore, aircraft components are not designed for exposure to some of the additives present in automotive/truck engine oils. Because aircraft lubricants are relatively free of additives, it is difficult to identify contamination of automotive/truck oil with aircraft oil, but it is also less serious.
- 9.4.4. **Operational byproducts.** Acidic compounds produced from the burning of sulfur or phosphorus impurities in fuel, incomplete combustion of hydrocarbon fuels, or nitrogen oxides formed from air at operating temperatures all attack metallic engine parts, corroding them. They also react with seals and gaskets, reducing their lifetimes.
- 9.4.5. **Fuel.** Excessive levels of fuel (about 5% by weight or higher) pose a safety risk by making the oil combustible or even flammable. Fuel incursion lowers viscosity, which, in turn, reduces lubricity. It also decreases thermal conductivity. Fuel incursion is primarily a concern for ground equipment and diesel engines.
- 9.4.6. **Wear debris.** Depending on the level of debris and the component, the debris may be normal or abnormal. In precision gas turbine engines, even small amounts of wear debris can signal an impending engine failure. The wear debris limits for aeronautical equipment are given in JOAP Manual Volume III. The wear debris limits for ground equipment are given in JOAP Manual Volume IV. Safety of flight dictates that special attention is given to aircraft. As a rule, limits for aircraft are much lower than limits for ground equipment or diesel engines on ships. Wear debris results should ideally be diagnostic (identifying what part is failing) and prognostic (how long that part will last). When coupled with knowledge of the engine composition and design, wear debris analysis is an important aspect to a condition-based maintenance program.

9.5. Mandatory actions for addressing contamination

- 9.5.1. **Environmental debris and water.** Recommend resampling and retesting when dust, dirt, sand, soil, clay, or water is suspected. Confirm proper instrument function with appropriate check standards.

Recommend continual flushing, sampling, and testing until contamination is undetectable (< 8.0 ppm Si if no limit given) or nearly so. Consult program manager if further information is needed. Compare results with reported limits in JOAP Manual Volumes III and IV limit tables.

9.5.2. **Visible particulate debris.** When visible debris is present, regardless of the nature of the debris (wear or environmental), the sample fails automatically. Confer with mechanic or maintenance chief if appropriate to ensure sample was not contaminated during/after collection. Recommend resampling or draining/flushing if evidence indicates. Test to identify and quantitate wear debris in original sample and any additional samples.

9.5.3. **Wrong fluid type.** Report results suggesting wrong fluid type as soon as practical; recommend resampling and retesting. Confirm proper instrument function with appropriate check standards. When wrong fluid type has been verified, notify local chain of command, oil analysis program manager, maintenance chief, cognizant engineering authority (Army and Navy only), and other personnel as required by local written procedures. When contamination has been identified in sealed materials procured through the Defense supply system, initiate action through the Defense supply deficiency reporting system. Recommend continual flushing, sampling, and testing until contamination is undetectable (< 8.0 ppm Zn and B) or nearly so. Consult program manager if further information is needed.

9.5.4. **Operational byproducts.** Report results as required for individual components or equipment. Report recommendations for additional sampling and testing or maintenance as required. Further detail is provided elsewhere in the manual.

9.5.5. **Wear debris.** When metallic debris consistent with component wear is confirmed by rotrode atomic emission spectrometry, take action consistent with the wear limit tables in JOAP Manual Volumes III and IV.

4. Validation: These changes were validated by Dr. Edward T. Urbansky and Mr. Michael Cassady, JOAP TSC, Pensacola, FL, Code 00.

5. Related instructions:

A. For paper copy: Maintain this IRAC with the applicable manual by placing or attaching it directly behind the title page. Mark the specific change area in the margin of each page affected with a vertical line, and include the IRAC number

and date time group (DTG) of the message. This IRAC shall not be removed until receipt of the formal change pages.

- B. For IRACs affecting manuals on CD-ROM: affix an adhesive label to the CD-ROM case, annotate with the applicable publication number, IRAC number, and DTG of the IRAC message. The label should be positioned to allow additional updates as they occur. Maintain the IRAC on file until receipt of the superseding CD-ROM.
- C. Subject IRAC shall be incorporated into the applicable manual no later than 12 months after issue date by JOAP TSC Pensacola FL, Code 00//